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PROGRAM DIRECTIVE

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APOLLO APPLICATIONS PROGRAM DIRECTIVE NO. 11

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JECT : Sequence and Flow of Hardware Development and Key  
Inspection, Review and Certification Checkpoints

ERENCE: a) NHB 5300.5-AAP Reliability & Quality Assurance Program  
Plan  
b) NHB 8080.3-AAP Test Requirements  
c) NPC 200 series-Quality Program and Inspection Provisions  
for Space System Contractors

#### PURPOSE

The purpose of this directive is to define the reviews, inspections and certifications which are key checkpoints for the Apollo Applications Program. These checkpoints are oriented to the hardware design, development, fabrication and test as well as mission phases of the Program. The basic management principle for requiring these reviews, inspections and certifications is to insure that, at appropriate and progressive points in the program life cycle, sufficient visibility is obtained of the status of design, manufacture and testing to adequately determine the integrity of the system prior to mission accomplishment.

#### SCOPE

The seven key checkpoints are:

1. PRR - Preliminary Requirements Review
2. PDR - Preliminary Design Review
3. CDR - Critical Design Review
4. CI - Configuration Inspection
5. COFW - Certification of Flight Worthiness
6. DCR - Design Certification Review
7. FRR - Flight Readiness Review

The PRR, PDR, CDR, CI, and COFW are accomplished at selected end item levels. The PRR, PDR & CDR concern themselves with the adequacy of the design of the hardware through its various stages; the CI & COFW with the hardware; and the DCR and the FRR encompass the total mission complex. Progression through each checkpoint is dependent on the availability of documentation and hardware upon

which to conduct the reviews, inspections and certifications to insure that each successive checkpoint provides a more comprehensive assessment of program accomplishment as it matures. (See Figure 1).

The PRR is the earliest technical review of the various concepts considered and of the concept selected to meet the mission objectives. Design is then begun and the PDR is a technical review of the basic design approach conducted early in the detail design phase. The CDR is a technical review of specifications and drawings conducted when the detail design is substantially complete. In addition to the review of the end item design itself, its compatibility with other portions of the system will be examined.

The CI is an examination of the manufactured end item against the specification requirements, released engineering drawings and test results. It may be conducted in 2 parts: prior to final systems test, when the configuration and overall status of the equipment and its GSE, as well as qualification test data are examined; and shortly before delivery, when final systems test data and acceptance test data are examined. Subsequent to CI, the item will be accepted on a DD-250 subject to all the requirements of acceptance contained in the specification. Regardless of the status of prior reviews a CI should be conducted on each major end item of flight hardware as well as those major test articles specified by the AAP Program Director. The COFW certifies that each flight stage and module is a complete and qualified item of hardware prior to shipment and is accompanied by adequate supporting documentation. It may be conducted concurrently with the CI. The DCR assesses and certifies the design of the total mission complex, and the FRR validates that the total mission complex is operationally ready.

The AATR, NHB 8080.3, the R&QA Program Plan, NHB 5300.5; and NPC 200 series documents contain general requirements for test, reliability and quality assurance. To the extent these requirements affect or pertain to Contract End Items, they should be reflected in the appropriate sections of the Contract End Item Specifications. The specifications will then contain all the technical requirements imposed by AAPO documents and will serve, along with the drawings, as the primary documents against which contract end item reviews, inspections and certificates will be accomplished. It is recognized that it may be desirable from

the Program Managers' viewpoint to conduct additional reviews, inspections and certifications to validate the compatibility of the specifications, drawings, hardware and test results. Summaries of each of the above inspections, reviews and certifications are contained in Section III of this Directive. It is also recognized that due to the advanced state of design, it may be necessary to conduct some reviews concurrently. Approval for conducting combined reviews should be obtained by the Development Center from the Director, AAP.

#### PROCEDURES

##### A. PRR - Preliminary Requirements Review

The purpose of a PRR is to verify by formal review the suitability of the conceptual configuration and to establish the requirements and action necessary to achieve a design baseline at the PDR. The PRR establishes:

1. The rationale of the selected configuration approach for the End Item with the mission objectives.
2. The end item suitability of the selected configuration by reference to drawings, study reports, etc.
3. The expected suitability of the end item configuration to meet the required schedule.
4. The feasibility and development tests required to select and substantiate design approaches.
5. Operational requirements generated by the selected configuration and design concept.

##### B. PDR - Preliminary Design Review

The purpose of a PDR is to verify by formal review the suitability of the baseline design of the Contract End Item early in the detail design phase.

The PDR establishes:

1. The compatibility of the selected design approach for the Contract End Item with the Contract End Item Spec. Part I or equivalent.
2. The system compatibility of the design approach with other flight hardware and ground based facilities by reference to predesign drawings, schematic diagrams, layout and envelope drawings, inboard profiles, review of performance characteristics for functional compatibility, etc.

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3. The integrity of the design approach by review of design analyses, breadboard models, mockups, circuit logic diagrams, packaging techniques, test and study results, reliability analyses, etc.
  4. The producibility of the selected design approach by review of requirements for special tools and facilities.
  5. The compatibility of the design approach with safety requirements by review of test results or source data.
  6. The adequacy of the planned test program for the contract end item by review of a preliminary test plan. This should include correlation of development and qualification tests with performance/design requirements by completion of Part I of the CEI Specification including the verification matrix, as set forth in NHB 8080.3, Apollo Applications Test Requirements.
  7. The suitability of the configuration for operations from an examination of mockups, engineering simulators, and drawings.
  8. A highlight of real or potential problem areas.
  9. An assessment of the acceptability of the design baseline.
- C. CDR - Critical Design Review

The purpose of a CDR is to verify by formal review the suitability of the design of a Contract End Item when the design is essentially complete. The product configuration specification is established following execution of the changes ordered at CDR.

The CDR establishes:

1. The compatibility of the design of the Contract End Item with the CEI Part I or equivalent. The CEI Part I should have been updated since the PDR and should include a further refinement of the correlation of development, qualification, reliability and integrated systems tests with performance/design requirements. The CEI Part II should also be complete including correlation of acceptance test requirements with the performance/design configuration.
2. The compatibility of the completed design of the Contract End Item with the entire system through ICD's, schematics and functional block diagrams. To be established also, is the system compatibility of the CEI with the totality of the mission equipment with which it is to function

in flight (e.g., compatibility of experiment w/modules, compatibility of spacecraft with Launch Vehicles).

3. The integrity of the design by review of analytical and test data, and supporting documentation, reliability assessment and analysis.
4. The adequacy of the design from a safety standpoint through a review of the design and test results.
5. The adequacy of the test program planned.
6. Adequacy of equipment and test facilities and special equipment from the standpoint of meeting the functional requirements as well as availability in accordance with schedule requirements.
7. Adequacy of design for operations by review of engineering simulation, tests, and study results and by examination of mockup, operating procedures, and systems performance data.

D. CI - Configuration Inspection

The purpose of the CI is to certify that the configuration for the Contract End Item as being offered for delivery is in conformance with the baseline established at CDR (modified by approved changes). It is accomplished by establishing the exact relationship of the CEI as described by released engineering documentation to the CEI as manufactured and assembled. The products of a CI include:

1. Acceptance of Part II of the CEI specification, or equivalent.
2. Identification of waivers and deviations to Part I of the CEI specification, or equivalent.
3. Validation of development, qualification and acceptance testing. This will include identification of failures that have occurred, the corrective actions taken, tests planned but not completed, and mission critical GSE.
4. Status of critical life components and life remaining.
5. Documented DD-250 indicating shortages and open work items which must be resolved prior to the FRR.
6. A plan for correcting open work items to be accomplished.

7. Comparison of the configuration of the end item unit, undergoing CI with the end item unit qualified or undergoing qualification if they are not the same unit.

The Configuration Inspection Review may be conducted in two phases:

Phase I - Approximately one week prior to start of final systems test, review the systems qualification status and test data, configuration and overall status of the CEI and its GSE.

Phase 2 - Approximately one week prior to delivery review the final systems test data.

#### E. COFW - Certification of Flight Worthiness

The purpose of the COFW milestone is to certify that each flight stage module and experiment is a complete and qualified item of hardware prior to shipment and is accompanied by adequate supporting documentation. The COFW procedure informs the Apollo Applications Program Director of any deficiencies prior to shipment from the manufacturing site and from the static firing site. The COFW is prepared prior to shipment from point of manufacture and is endorsed by the center program manager or his designee prior to shipment. When equipment is shipped to an intermediate destination (center test facility or contractor's plant) for additional work, further signoff of the COFW by the cognizant center program manager(s) shall be accomplished. Upon completion of the FRR, the COFW shall be jointly endorsed by the Program Manager of KSC and the center having development and production cognizance over the equipment.

The COFW certifies that:

1. Complete specifications and drawings have been developed in accordance with contractual requirements. Additionally the exact relationship of the Contract End Item as manufactured and assembled has been established and that shortages which must be resolved prior to FRR have been indicated on a documented DD-250.
2. Acceptance, qualification and reliability demonstration tests have been successfully completed and meet the specification requirements.
3. Departures from specification and drawing requirements have been approved by Material Review Boards in accordance with NPC 200-2, Quality Program Provisions for Space System Provisions Contractors, Section 8.1.

4. Critical hardware failures have been analyzed and corrected in accordance with NPC 250-1, Reliability Program Provisions for Space System Contractors, Section 3.7.
5. Hardware qualification program has been satisfactorily accomplished in accordance with contractual requirements.
6. Hardware is complete and in accordance with the Narrative End Item Report as specified in NPC 200-2, Section 14.2.4.
7. Data for operation and checkout is complete and compatible.
8. Interface Control Drawings have been met and that interface compatibility is certified.
9. Shipping requirements of NPC 200-2, Section 11-6 have been met.
10. The DD-250 is ready for signature.

NOTE: CI and DD-250 data requirements applicable to the COFW shall be used for the COFW.

F. DCR - Design Certification Review

The purpose of a DCR is to examine the design of the total mission complex for proof of design and development maturity and to:

1. Assess and certify the design of the Space Vehicle for flight worthiness and manned flight safety, and
2. Assess and certify for manned Apollo Applications missions the design of the Launch Complex, the Mission Control Center, the Manned Space Flight Network and Launch Instrumentation.

The following are to be performed at a DCR:

1. Review of space vehicle elements (modules, stages, major structures such as MDA, etc.), support and operations facilities, relating equipment performance and support capability to mission objectives, requirements, and applicable specifications. Emphasis should be placed on interface compatibility between all elements, i.e., launch vehicle to spacecraft, experiments to spacecraft, GSE to stage, GSE to facilities, and GSE to GSE.

2. Review of test status, problems solved and yet to be solved, status of flight equipment and performance in test to date. Those items significant to performance capability should demonstrate design maturity.
3. Detailed review by Flight Operations and Flight Crew of the mission rules and contingency plans. All mission constraints and areas of low confidence levels shall be emphasized. Evidence of crew training shall be presented.
4. Review by flight crew of pre-flight preparation program, including spacecraft and hardware design verification, flight planning, flight crew procedure development, and crew training.
5. Certification by Quality as to capability of system to perform with acceptable reliability.
6. Certification by Flight Safety as to system conformance with safety criteria. A review shall include possible accidents, related causes, and relative risks involved.
7. Summary assessment of the Launch Instrumentation Facility unresolved problems and plans for corrective action.
8. Summary assessment of the Manned Space Flight Network including unresolved problems and plans for corrective action.
9. Identification of open items by Apollo Applications Program Director and procedures for closing out.

If the total mission complex is certified for flight worthiness and manned safety, a Mission Design Certification Document will be executed.

G. FRR - Flight Readiness Review

The FRR will be conducted as a consolidated review of the hardware, operational and support elements to assess their readiness to begin the Mission. It is an evaluation of the state of readiness of the:

1. Launch Vehicle
2. Spacecraft
3. Experiments
4. Crew Readiness
5. Launch Site
6. Manned Space Flight Network
7. Flight Control Capabilities
8. Launch Support and Flight Support



9. Experiment Data Acquisition Capabilities
10. Recovery Planning
11. Medical Planning
12. Experiment Data Reduction & Distribution Planning
13. Public Information Planning

Its scope encompasses all documentation and prior formal reviews and agreements which will lead to an assessment of the readiness and safety of all hardware, software, operational and support elements to perform the mission. Emphasis is to be placed on reviewing any "exception" to a condition of full readiness or full qualification. The determination that all elements are ready to perform the mission will be by a review of the following elements for each of the above as appropriate:

1. Results of checkout and test.
2. Configuration status of Launch vehicles, spacecraft and experiments.
3. Computer program verification - ground and flight.
4. Waivers and deviations.
5. Development, qualification and reliability testing.
6. Critical life components and life remaining.
7. Maintainability assessment.
8. Status of logistics readiness.
9. Identification of shortages and open work items.
10. Reliability assessment.
11. Problems that may constrain the mission.

#### RESPONSIBILITIES

1. The conduct of the PRR, PDR, CDR, CI and COFW is the responsibility of the Manager of the AAPO at the Center having development responsibility for the end item. It is his responsibility to:
  - a. Insure that studies, engineering simulations, tests, and other work required to support each review as tabulated in Figure 1 are properly planned, coordinated and implemented.
  - b. Insure the participation of Headquarters, Centers, Experiment sponsors, and contractors prior to and during reviews in a timely and appropriate manner. It is stressed however, that the responsible Center Manager will exercise judgment as to the depth and amount of participation in conducting each review.
  - c. Insure that appropriate information relative to the review is made available to participants in sufficient time to permit its careful study. Normally, a review by supporting personnel will be made prior to the PRR, PDR and CDR on

models, mockups, trainers and flight hardware so that comments may be formally evaluated and their requirements incorporated into the design.

- d. Certify, within 60 days after the completion of each review, to the AAP Director that the objectives of the review have been met. The following documentation, or appropriate references should accompany the certification.

- (1) PRR - Design Requirements
- (2) PDR - Baseline Design Document
- (3) CDR - Design Specification

2. The DCR will be conducted by the Management Council acting as the Design Certification Board. The Apollo Applications Program Director will be responsible for organizing the DCR. The conduct of the FRR is the responsibility of the Apollo Applications Program Director acting with the Mission Director of OMSF.

# REVIEW - OBJECTIVES and GUIDELINES

Review	Applicable To	Objective of Review	Review Criteria	Required To Support Review	Time of Review
RRR	Each module Each stage Each experiment	Configuration concepts Design approach Schedules Systems functional description	Mission requirements Prod. crew requirements Experiment Proposal Experiment Implementation Plan Experiment Compatibility Study	Drawings Study reports Models Sketches	Completion of conceptual design Shortly after experiment development contract award
PDR	Each module Each stage Each experiment	Basic Design Approach Selected configuration Prod. systems compatibility Integrity of design approach Producibility Safety assessment Planned test program Crew compatibility assessment Proposed mounting & storage arrangement	CEI Part I or equivalent Safety criteria NHB 8080.3 Crew criteria NHB 5300.5	Pre-design drawings Schematic drawings Layout & envelope drawings Inboard profiles Mockup/Trainees Design analyses Reliability analyses Preliminary ICD's Test requirements	Completion of Preliminary Design
CDR	Each module Each stage Each experiment	Configuration design Systems compatibility End Item-to-End Item compatibility Design integrity Reliability assessment Safety assessment Schedule	CEI Part I, or equiv. CEI Part II, or equiv. Safety criteria NHB 8080.3 Crew criteria NHB 5300.5	Detail design drawings ICD's Schematics Analyses Test requirements Test plans and results	95% of drawings released for manufacture or Detail design complete
CI	End Item or Specified major test article	Configuration as manufactured Identify waivers & deviations Validate qualification tests Assess systems tests G3 for end item Sign DD-250	CEI Parts I & II, or equiv. NHB 8080.3 NHB 5300.5	Qual test data Final systems test data Tech data Drawings and Specifications	Shortly before acceptance
COFM	Each stage/module equipment end item	Assess deficiencies Acceptance, qualification & reliability demonstration tests Reliability assessment Interface compatibility	All prior documentation NHB 8080.3 COB Directives NFC 200-2 NFC 250-1 NHB 5300.5	Complete specs and drawings Approved ECP's Operation & checkout procedures Shipping requirements ICD's	Shipment
DCR	Total Mission Complex	Certify space vehicle and G3 flight worthy Test status Design of Launch Complex Mission Control Center Manned Space Flight Network & Launch Instrumentation Identify open items Sign Mission Design Certification	NHB 8080.3 Mission rules Contingency plans NFC 200-2 NFC 250-1 Safety criteria NHB 5300.5	ICD's Test results Reliability data Safety data	4 months prior to launch
FER	Flight hardware Support equipment	Configuration Safety Mission requirements	Mission objectives and program specifications NHB 5300.5	All hardware and software data	Shortly before launch

Figure 1

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AP/Roth (5)  
AS/Wagner  
AT/Day (5)  
C/Freitag  
F/Evans  
M/Humphreys  
M/McLaughlin (2)  
O/Stevenson  
P/Kubat (2)  
S/White  
SR/Davis  
T/Lord (3)  
L/Mathews  
LD/Disher  
LG/Hubbard  
L-1/Levenson (2)  
LV/Fero  
LA/Culbertson (12)  
LO/Edwards (5)  
LP/Field (12)  
LR/Cohen (4)  
LS/Hagner (7)  
LT/Savage (14)

SSA

/Naugle  
D/Nicks  
SE/Johnson (3)  
SM/Foster (5)

DART

R/Adams  
R/Eggers  
RD/Myers (37)  
RNV/Novik (5)  
RF/Ginter  
  
XP/Jones (2)  
L/Weakley (3)  
BB/Velander (3)

OTDA

T/Truszynski  
TS/Pozinsky  
TR/Bryant

OPPA

PT/Maggin

GSFC

110/Stroud  
800/Covington  
810/Roberts  
820/Wood  
614/Milligan (2)

KSC

CD/Debus  
DM/Siepert  
DO/Ross  
AD/VanStaden  
AA/Morgan  
AA-ADV/Hock  
AA-PCO/Halcomb (60)  
LO/Petrone  
AP/Middleton  
EX/Murphy  
TS/Clark  
DE/Preston  
IS/Miller  
SO-PLN/Manton  
AP-PCO-3/Kent

MSC

AA/Gilruth  
AB/Deputy Director  
KA/Thompson (65)  
PA/Low (3)  
EA/Faget (5)  
TA/Hess (5)  
ET/Stoney  
FA/Kraft (5)  
CA/Slayton (5)  
DA/Berry (2)  
ZR-1/Green  
NA-SA/Bond (5)  
BM-1/Grant (2)  
CA/McElmurry

von Braun  
laus  
IR/O'Connor  
IR/Mrazek  
S/Speer  
/AA-MGR/Belew  
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